Accelerating Infrastructure Innovations

FOCUS

September 2003

INSIDE

U.S. Department of Transportation

Federal Highway Administration

Partnerships, Innovation Build a Bridge in South Carolina

In 1929, the first bridge over the Cooper River and Town Creek in Charleston, South Carolina, opened with a 3-day gala celebration. The 4.36-km (2.71-mi) bridge, later to be known as the Grace Memorial Bridge, was the fifth largest structure of its type in the world at that time. The landmark bridge was followed by construction of a second structure over the Cooper River, the Pearman Bridge, which opened to traffic in 1966. In recent years though, it became clear to the South Carolina Department of Transportation (SCDOT) and the community that the two bridges had become functionally obsolete. The Grace Memorial Bridge has only two 3-m (10-ft) lanes, lacks shoulders, and has only a limited ability to carry vehicles weighing more than 5 tons. The Pearman Bridge, meanwhile, provides two northbound lanes and one southbound lane, but does not have emergency shoulders or a median to separate opposing traffic. And neither bridge has enough vertical or horizontal clearance to safely accommodate today's larger shipping vessels. "The two older bridges were congested and in dire need of replacement," says Charles Dwyer of the SCDOT.

Replacing the two bridges with a new Cooper River Bridge has required the SCDOT and the Federal Highway Administration (FHWA) to identify innovative sources of funding for the massive project and to work closely with residents, city and town officials, and others in the surrounding communities to choose a context-sensitive design that would fit in with the historical aesthetic of the city and to minimize the impact of the construction on the community.

A design/build contract for the new Cooper River Bridge was executed in July 2001 with Palmetto Bridge Constructors (PBC). PBC is a joint venture of Skanska USA and HBG Constructors. The lead designer is Parsons Brinckerhoff. Construction of the bridge is required to be completed by 2006. Construction has been accelerated, however, and the contractor is now aiming to complete work early by having both directions of traffic using the new bridge in the summer of 2005. As of August 2003, more than 50 percent of the bridge's concrete had been placed. The use of the design-build concept has helped accelerate the completion of the largest single infrastructure contract in SCDOT's history.

The new Cooper River Bridge will have the longest cable-stay span in North America, stretching 471-m (1,546 ft) across the Cooper River. The total length of the bridge

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This view of the new Cooper River Bridge under construction in Charleston, SC, shows reinforcing steel in the bridge's Eastern Tower.

South Carolina Bridge,

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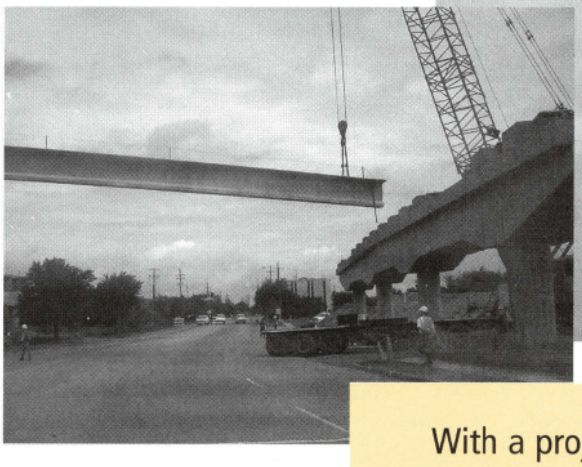
Right and below: Large concrete girders for the new bridge are set in place.



is 4.02 km (2.5 mi). A diamond tower design was chosen after several public hearings provided feedback on various design options. "There was a lot of public input as to what the structure would look like. The community involvement has been an ongoing effort," says Tad Kitowicz of FHWA's South Carolina Division Office. "We have held a lot of public hearings and worked hard to involve residents. As Charleston is a historic city, we need something that will fit with the surrounding area and become a landmark of the city," adds Dwyer. A 3.6-m (12-ft) bicycle and pedestrian lane was added to the design at the urging of the local community. The lane includes observation sites with benches. Additional interchange ramps were also added after consultation with local officials. To encourage public input and feedback on the project and provide information, a Community Bridge Office was set up. A Web site (www.cooperriverbridge.org) has also provided frequently updated news and information on the project.

With a project budget of $677 million, SCDOT had to develop an innovative financing plan that includes several partners.

The first concrete girder is set into place between two pier caps for the new bridge's Meeting Street off-ramp.

The new bridge's cable-stayed span will be suspended by 128 cables from two diamond towers at each end of the span. The cables are to be anchored on the bridge's deck level and inside of the diamond towers. To protect them from weather conditions, the bridge cables will be enclosed in a high density polyethylene pipe. The diamond towers will support an eight-lane road deck that is almost 61 m (200 ft) above the median high tide mark. Platforms and tower elevators that can be used for safety inspections and maintenance have been incorporated into the design.

With a project budget of $677 million, SCDOT had to develop an innovative financing plan that includes several partners. The South Carolina Infrastructure Bank, which was established by the State in 1997 to provide loans and other financial assistance for major projects, has contributed $325 million in funding. A $215 million Federal loan was provided under the Transportation Infrastructure Finance and Innovation Act, which is being repaid by SCDOT, Charleston County, and the South Carolina State Ports Authority. Additional funding has come from FHWA.

To learn more about the Cooper River Bridge Project, visit the Cooper River Bridge Web site at www.cooperriverbridge.org or email the SCDOT at info@cooperriverbridge.org. *

Blue Ribbon Panel Issues Recommendations for Bridge and Tunnel Security

In the wake of 9/11, protecting the Nation's critical bridges and tunnels from terrorist attack has presented a new and largely unexpected challenge for highway agencies. Meeting this challenge is the subject of a new report, *Recommendations for Bridge and Tunnel Security,* issued by the Blue Ribbon Panel on Bridge and Tunnel Security. In cooperation with the American Association of State Highway and Transportation Officials (AASHTO), Federal Highway Administrator Mary E. Peters formed the panel last fall to provide guidance to highway agencies. As the report notes, "the highway infrastructure has vulnerabilities, which must be addressed. This is important enough to be a matter of national security policy." The panel stressed that loss of a critical bridge or tunnel at one of the numerous "choke points" in the highway system could result in hundreds or thousands of casualties, billions of dollars worth of direct reconstruction costs, and even greater socioeconomic costs.

While the panel looked at a range of infrastructure security topics, including issues relating to management and operational practices, information security, and mobilizing and responding to threats or attacks, the report's recommendations primarily address near- and long-term design and engineering solutions to bridge and tunnel vulnerabilities. The panel recommends collaboration by the Federal Highway Administration (FHWA), AASHTO, the Transportation Security Administration (TSA), and other transportation stakeholders to prioritize all bridges and tunnels with respect to their vulnerability to terrorist attack. This prioritization should be based on such characteristics as:

- Potential for mass casualty based on average daily traffic and other statistics.
- Criticality to emergency evacuation and response plans.
- Importance to military or defense mobilization.
- Availability of alternative routes with adequate capacity.
- Symbolic value of structure and potential for extensive media exposure and public reaction.
- Mixed use of structure, such as by both automobiles and rail.
- Location at international border crossings.

Once the initial prioritization is accomplished, the report notes, security solutions should be engineered and FHWA, as the Nation's primary Federal agency with the necessary engineering expertise, should work with TSA to, among other things, administer fund allocation to responsible agencies to meet high priority security needs. The panel also stressed that bridge and tunnel security issues should be addressed with new funding provided beyond and outside of current Federal-aid highway funding sources.

As engineering standards do not exist regarding security concerns for bridges and tunnels, the panel recommends developing appropriate research and development (R&D) initiatives. The goal of the R&D initiatives is to create empirically validated computational tools, design methodologies, and hardening technologies that engineers can use to "design for the terrorist attack." The report notes that the initiatives "are interrelated and interdependent and should be pursued simultaneously." These initiatives should:

- Assess the performance of critical elements under credible loads (including load reversals).
- Validate and calibrate computational methods and modeling with experiments to better understand structural behavior from blast loads and thermal loads.
- Determine the residual functionality of bridge and tunnel systems and their tolerance for extreme damage.
- Develop mitigation measures and hardening technologies.

In addition to these recommendations, the panel suggests that AASHTO work with university engineering departments to develop curriculum for educating students and bridge professionals on security issues. The panel also recommends that the Department of Homeland Security work jointly with industry and State and local governments to identify potential technologies and standards that will provide better and more cost-effective protection against terrorism.

Federal and State agencies and other highway infrastructure owners are already moving to address the panel's overarching recommendations. FHWA, AASHTO, and the U.S. Army Corps of Engineers have formed a technical team to work with TSA to develop countermeasure options and threat scenarios to include in a national risk assessment model. To complement this effort, AASHTO will also work with FHWA and TSA to develop an *AASHTO Guide to Risk Management of Multi-Modal Transportation Infrastructure.* This will be an update to the

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Value Engineering 2003: Conference Features Success Stories, Lessons Learned

Value engineering (VE) success stories and lessons learned from across the United States and worldwide were in the spotlight at the 2003 American Association of State Highway and Transportation Officials'/Federal Highway Administration (AASHTO/FHWA) Value Engineering Conference. Held in Tampa, Florida, from July 15–18, 2003, the conference drew 145 attendees, including many international participants. The event featured three tracks: Case Studies, Starting and Maintaining a VE Program, and Advanced Tools and Techniques.

"The conference was good for the people just getting into value engineering and also useful for the long-term practitioners," noted Jim St. John, Division Administrator in FHWA's Florida Division Office. "You could see a lot of mentoring going on during the sessions. It was really a community of practice." In addition to the State highway agencies that participated, engineers came from Greece, Japan, India, Canada, Korea, and other countries to learn more about the VE concept and process.

Using the VE process, a highway agency reviews a project's features and looks for ways to improve quality, foster innovation, and lower owner costs. A VE study typically takes 4–5 days to perform and involves a multidisciplinary team. At the concept stage, this team might include planning and right-of-way staff, environmentalists, and private citizens. A study done during the design phase of a project might involve a team of construction, design, traffic, and maintenance staff.

Conference sessions looked at everything from the basics of VE to setting up a VE training program to incorporating VE with design-build contracting. A presentation on the Florida Turnpike's Orlando South Interchange looked at how VE analysis was used to improve this often confusing interchange, which connects two freeways and three surface streets. Eight of 12 recommended VE alternatives have been accepted to date, at an estimated cost savings of $48.4 million. In Ottawa, Canada, meanwhile, VE review of the planned rehabilitation of King Edward Avenue identified significant potential cost savings. King Edward Avenue is a main arterial route in Ottawa that also leads across the Ottawa River to the Province of Quebec, serving as the primary interprovincial link for car and truck traffic. The VE analysis was performed in the planning stage of the project. An independent team identified $6 million in potential savings from the original project budget of $18 million. The VE recommendations included making modifications to the interchange design at the North End of the project.

Using the VE process, a highway agency reviews a project's features and looks for ways to improve quality, foster innovation, and lower owner costs.

The California Department of Transportation (Caltrans) highlighted lessons learned from its Caltrans Value Analysis (VA) Program. Over the last 7 years, Caltrans has completed 175 VA project studies, resulting in cost savings of $870 million and a return on investment of 92:1. Other benefits of the Caltrans VA process is that it saves on project development time, provides a method to quantify the project scope, and helps in building consensus among project stakeholders. Key project performance criteria that are analyzed include the highway operations, system preservation, and environmental impact aspects of a project, as well as the project schedule. "The VA program assures the project stakeholders that viable alternatives have been thoroughly considered and evaluated," said George Hunter, the VA Program Director for Caltrans.

Ken Smith of the Washington State Department of Transportation (WSDOT) reported on the many resources available in AASHTO's VE Toolbox, which can be found on the AASHTO VE Web site at www.wsdot.wa.gov/eesc/design/aashtove. The toolbox includes VE evaluation and criteria matrixes and a cost model. Also available are Caltrans' Value Analysis Report and Team Guide and the WSDOT's VE Study Template, information on Value Engineering for Small Transportation Projects, and a Value Engineering Workbook Template.

The conference also featured the presentation of the FHWA Value Engineering Outstanding Achievement Awards, which recognize accomplishments by State highway VE programs over the past 2 years, and the AASHTO National Value Engineering Awards, which honor outstanding VE projects. The FHWA awards were presented to Florida, New Jersey, Tennessee, and West Virginia (see sidebar).

The AASHTO awards were given for the Most Value Added Project and the Most Innovative Project in the categories of Design Engineering, Process Improvement, and Construction (see sidebar).

To learn more about the 2003 VE Conference, visit the AASHTO VE Web site at www.wsdot.wa.gov/eesc/designaashtove. Presentations and abstracts from the conference have been posted on the site. For more information on VE, contact Donald Jackson at FHWA, 202-366-4630 (fax: 202-366-3988; email: donald.jackson@fhwa.dot.gov) or check the FHWA VE Web site at www.fhwa.dot.gov/ve/index.htm.

FHWA VE Outstanding Achievement Awards

FHWA's 2003 Value Engineering Outstanding Achievement Awards recognized Florida, New Jersey, West Virginia, and Tennessee for their overall VE accomplishments. The Florida Department of Transportation has been a leader nationwide in VE since it started its program in the mid 1970s. Over the past 8 years, Florida has conducted more than 450 VE studies and realized nearly $1.3 billion in implemented cost avoidance recommendations. The average return-on-investment rate of the VE studies is 110:1. To better share its VE results, Florida is developing a new informational database that will be accessible through the Internet.

The New Jersey Department of Transportation (NJDOT) created its VE Unit in 1989. A Department reorganization in 1996 then led to an expanded VE group. Since 1999, NJDOT has saved more than $60 million annually from preconstruction VE studies. Starting in 2000, the VE Unit also began evaluating road user costs to determine the most cost-effective staging for projects. These analyses have led to VE recommendations that minimize road user delays and costs.

The West Virginia Division of Highways (DOH) first offered VE training to engineers and managers in 1978. Over the years, it has incorporated VE into its project development and construction processes, reporting in 2002 that it had saved $70 million as a result of VE proposals made over the previous 2 years. The DOH is currently building on its VE success by developing a new VE Handbook.

While the Tennessee Department of Transportation (TDOT) has been conducting VE studies for almost 16 years, the appointment of a full-time VE coordinator in 1999 helped to revitalize its program. In 2002, Tennessee conducted 20 VE studies and realized more than $4 million in savings. TDOT is implementing a database system this year to track all VE studies and their recommendations and has also started a VE Web site.

AASHTO National VE Awards

In the construction category, the Ohio Department of Transportation received the Most Value Added award for its work to completely remove and rebuild an eight-span continuous steel girder and concrete deck bridge over the Ashtabula River in Ashtabula, Ohio. The VE recommendations changed the superstructure from steel girders to precast concrete beams; added one more beam line; redesigned the bridge deck; and changed the substructure by adding one pier, redesigning all piers, and eliminating the drill shafts. Following these recommendations saved $962,744 off the original contract price of $10,699,682.

The Florida Department of Transportation was honored with the Most Innovative Construction award for its project on SR 60A from Agricola Road to Broadway Avenue in Bartow, Florida. The project originally called for constructing two bridges with a center island that separated the West Bartow Front Porch Community from the rest of the town. The Value Engineering Change Proposal (VECP) submitted by the contractor proposed a single structure, eliminating the center island and reconnecting the West Bartow Front Porch Community with the rest of the town. This VECP reduced the construction time by 125 days and saved approximately $77,876.

NJDOT received the Most Value Added Engineering Award for its work on Route 1 & 9T and Route 7. This major artery handles port traffic and local and commuter traffic within the northern New Jersey and New York City region. The project will realign Route 1 & 9T and temporarily reconfigure the connection to the Route 7 bridge over the Hackensack River. Among other accomplishments, the VE recommendations have improved the construction staging, reduced the construction duration, and minimized road user costs. In all, the VE analysis reduced the $188.3 million project cost by $13.6 million.

The Most Innovative Engineering award went to the Texas Department of Transportation for its widening of US 82 from US 259 to IH 30. This 17.7-km (11-mi) section is a two-lane roadway with limited shoulders. The project will widen the road to four lanes, with a continuous flush median and 16-km (10-ft) outside shoulders. VE recommendations saved $1.5 million on the $25 million project.

Caltrans was honored with the Most Value Added During Process Improvement award for its VA study of the District 11 Right of Way Decertification Process. Typically, the process for decertifying State property for sale to the public takes about 20 months. VE recommendations for reducing this timeline shaved nearly 7 months off the process.

The award for the Most Innovative Process Improvement proposal went to WSDOT for its North Spokane Corridor Project. This $1.4 billion, 16.7-km (10.4-mi) initiative will connect I-90 to US 395. The VE study results included improved design schemes, reduced impacts on city parks, and preservation of existing ramp structures. The VE study also allowed for public input into the design process, which increased community acceptance of the project.

Join the High-Performance Concrete Community

Join the high-performance concrete team. The Federal Highway Administration's (FHWA) "virtual" team for high-performance concrete (HPC) has developed the online HPC Exchange as a comprehensive source of information on HPC use and technology. HPC is concrete that has been engineered to produce mixes that better meet the requirements of specific bridge or pavement projects, resulting in bridges and pavements that last longer and require less maintenance. Open to all, the Exchange site (knowledge.fhwa.dot.gov/cops/hpcx.nsf/home) features communities of practice on such HPC topics as:

- Definition and Research
- Structural Design and Specifications
- Mix Design and Proportioning
- Precast/Prestressed Beam Fabrication, Transportation, and Erection
- Cast-in-Place Construction
- Instrumentation, Monitoring, and Evaluation
- Costs
- Case Studies/Lessons Learned.

Each community contains a reference section with papers, articles, case studies, and other useful materials; a "works in progress" section where documents can be posted; a discussion section that invites users to post comments or questions; and a directory section with contact information for team members and other users. Visitors can also find information on upcoming HPC events. The site's Home Page features a "What's New" box, with information such as biographical profiles of new team members. To get the most out of the site, users can sign up for personalized daily email notifications based on their particular interests.

The virtual team's goal is to "build up and spread the wealth of information and knowledge on HPC technology and promote good practices," says Ben Tang of FHWA. Team members represent FHWA, State highway agencies, academia, and industry. Case studies included on the site range from an HPC Bridge Showcase project in Alabama to Colorado's construction of an HPC box-girder bridge. One posted topic that recently spurred a huge amount of interest dealt with HPC deck cracking. Almost half of the States responded with what they considered to be best practices for successfully mitigating this phenomenon.

"After less than 18 months in operation, the HPC Exchange continues to maintain a healthy index of use," says Site Administrator Lou Triandafilou of the FHWA Resource Center. For more information on the HPC Exchange or the HPC Virtual Team, contact Lou Triandafilou at 410-962-3648 (email: lou.triandafilou@fhwa.dot.gov). *

Other structural virtual teams that have been established to date include ones for segmental concrete bridges, high-performance steel, seismic engineering, tunnels, and fiber-reinforced polymers. To learn more, visit the following Web sites. *Focus* will also cover the teams in future articles. Additional teams are in the works, including those for cable-stay bridges, load and resistance factor design, accelerated bridge construction, and bridge monitoring.

Fiber-Reinforced Polymer Composites—www.fhwa.dot.gov/bridge/frp/index. htm

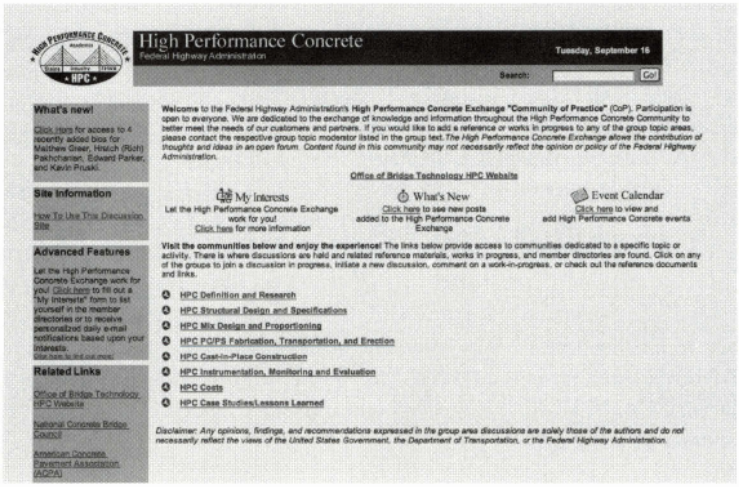
High-Performance Steel—www.fhwa.dot.gov/bridge/hps.htm

High Strength Bolts—www.fhwa.dot.gov/bridge/bolts.htm

Segmental Concrete Bridge Technology—www.fhwa.dot.gov/bridge/segmental/index.htm

Seismic Technology—www.fhwa.dot.gov/bridge/seismic/index.htm

Road Tunnels—www.fhwa.dot.gov/bridge/tunnel/index.htm



Highway Technology Calendar

The following events provide opportunities to learn more about products and technologies for accelerating infrastructure innovations.

Fifth National Conferences on Asset Management
September 29, 2003, Atlanta, GA
October 21, 2003, Seattle, WA

Sponsored by the American Association of State Highway and Transportation Officials (AASHTO) Task Force on Asset Management and the Federal Highway Administration (FHWA) Office of Asset Management, the event will include sessions on tools and technology, GASB 34, data integration, and local government experiences.

Contact: Ernie Wittwer or Sarah Brehm at 608-263-2655 (email: wittwer@engr.wisc.edu or sbrehm@engr.wisc.edu) or Jason Bittner at 608-262-7246 (email: bittner@engr.wisc.edu). Information is available online at gulliver.trb.org/conferences/asset.

Western Bridge Engineers' Seminar
October 5–8, 2003, Reno, NV

The seminar is a biennial cooperative effort by FHWA and the State Transportation Departments of Alaska, California, Idaho, Nevada, Oregon, and Washington State. It allows Government agencies, consultants, contractors, educators, and suppliers to exchange information on subjects of current interest in the design, construction, and maintenance of bridges.

Contact: Jean Canfield, Conference Manager, at 360-943-7732 (fax: 360-357-9607; email: jeancassoc@msn.com).

Third International Symposium on HPC
October 19–22, 2003, Orlando, FL

Sponsored by FHWA and the Precast/Prestressed Institute, the symposium will address the research, design, construction, performance, and benefits of high-performance concrete.

Contact: Jerry Potter at FHWA, 202-366-4596 (email: jerry.potter@fhwa.dot.gov) or Lou Triandafilou at FHWA, 410-962-3648 (email: lou.triandafilou@fhwa.dot.gov).

2003 New York City Bridge Conference
October 20–21, 2003, New York, NY

The conference features a technical program designed specifically for engineers. Such topics as bridge analysis and design, cable-supported bridges, advanced materials, and innovative bridge technology will be covered. The keynote session will include a discussion on methodology for assessing risk and prioritizing security improvements for bridges.

Contact: Khaled Mahmoud at the Bridge Engineering Association, kmahmoud@bridgeengineer.org or info@bridgeengineer.org. Conference information can be found online at www.bridgeengineer.org.

TEMP System Open House
October 23, 2003, Frederick, MD

The Open House will provide an introduction to Total Environmental Management for Paving (TEMP). Details of this concrete pavement testing system will be covered, including data record keeping, prediction of future strength, and data reporting.

Contact: Ted Ferragut at TDC Partners, Ltd., 703-836-1671 (email: tferragut@tdcpartners.com).

World Steel Bridge Symposium and Workshops
November 19–21, 2003, Orlando, FL

The symposium will cover such focus areas as short and intermediate span bridges, accelerated bridge construction, innovative bridge designs, and inspection and maintenance. The event is sponsored by the National Steel Bridge Alliance and FHWA.

Contact: Darice Elam at the National Steel Bridge Alliance, 312-670-7011 (fax: 312-670-5403; email: elam@nsbaweb.org).

Fourth National Seismic Conference and Workshop on Bridges and Highways
February 9–11, 2004, Memphis, TN

The conference will provide a forum for exchanging information on current national and regional practices for designing seismic-resistant bridges and highway systems and retrofitting existing structures and highways. An International Forum will feature speakers from various countries that have implemented advanced earthquake design and mitigation technologies and approaches. A Technology Show and Information Display will also showcase innovative technologies for earthquake engineering.

Contact: Wendy Pickering at the University of Illinois, 217-333-2880 (fax: 217-333-9561; email: fourthphseismicconf@ad.uiuc.edu; Web: www.conferences.uiuc.edu/seismic).

Asphalt Pavement Conference 2004: 21st Century Construction
March 15–16, 2004, Nashville, TN

The conference will focus on construction practices that are necessary to building hot-mix asphalt pavements that will last. Session topics will include paving and compaction, contracting practices, and plant operations. The conference is being held in conjunction with the World of Asphalt 2004 Show & Conference. Sponsors include the Asphalt Institute, National Asphalt Pavement Association, State Asphalt Pavement Associations, Tennessee Department of Transportation, American Association of State Highway and Transportation Officials, and FHWA.

Contact: For registration information, call 800-355-6635 (fax: 800-979-3365; email: info@worldofasphalt.com) or visit www.worldofasphalt.com.

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FHWA Administrator: Mary E. Peters

Managing Editor: Zachary Ellis
Tel: 202-493-3193 (fax: 202-493-3475)
zac.ellis@fhwa.dot.gov

Editor: Lisa Pope
Tel: 202-234-7157 (fax: 202-347-6938)
lgpope@woodwardcom.com

Federal Highway Administration (HRTS)
6300 Georgetown Pike
McLean, VA 22101-2296

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Send address corrections to:
Woodward Communications
1420 N St., NW, Suite 102
Washington, DC 20005
fax: 202-347-6938
email: lgpope@woodwardcom.com

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www.tfhrc.gov/focus/focus.htm

Blue Ribbon Panel,

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Guide published in 2002 that has already been used by many State agencies to assess their critical infrastructure.

FHWA has formed an Engineering Assessment Team for Security to provide technical advice on methods to prevent, mitigate, respond to, and recover from extreme events. The team will also provide training and technical support to infrastructure owners for risk assessments.

In partnership with the National Cooperative Highway Research Program, the AASHTO Task Force on Transportation Security has developed a research agenda to address security concerns for bridges and tunnels. Further, as recommended by the panel, FHWA has already taken efforts to build on the knowledge base available in the military by teaming up with the Corps of Engineers. This cooperative effort includes a multi-year Memorandum of Agreement to leverage resources for research, development, and training. Cooperative efforts with the Corps have already led to the development of workshops to train engineers to design for security.

For more information on the Blue Ribbon Panel Report, contact Steve Ernst at FHWA, 202-366-4619 (email: steve.ernst @fhwa.dot.gov). The report is available on the AASHTO Web site at security.transportation.org/community/security/studies.html. *

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